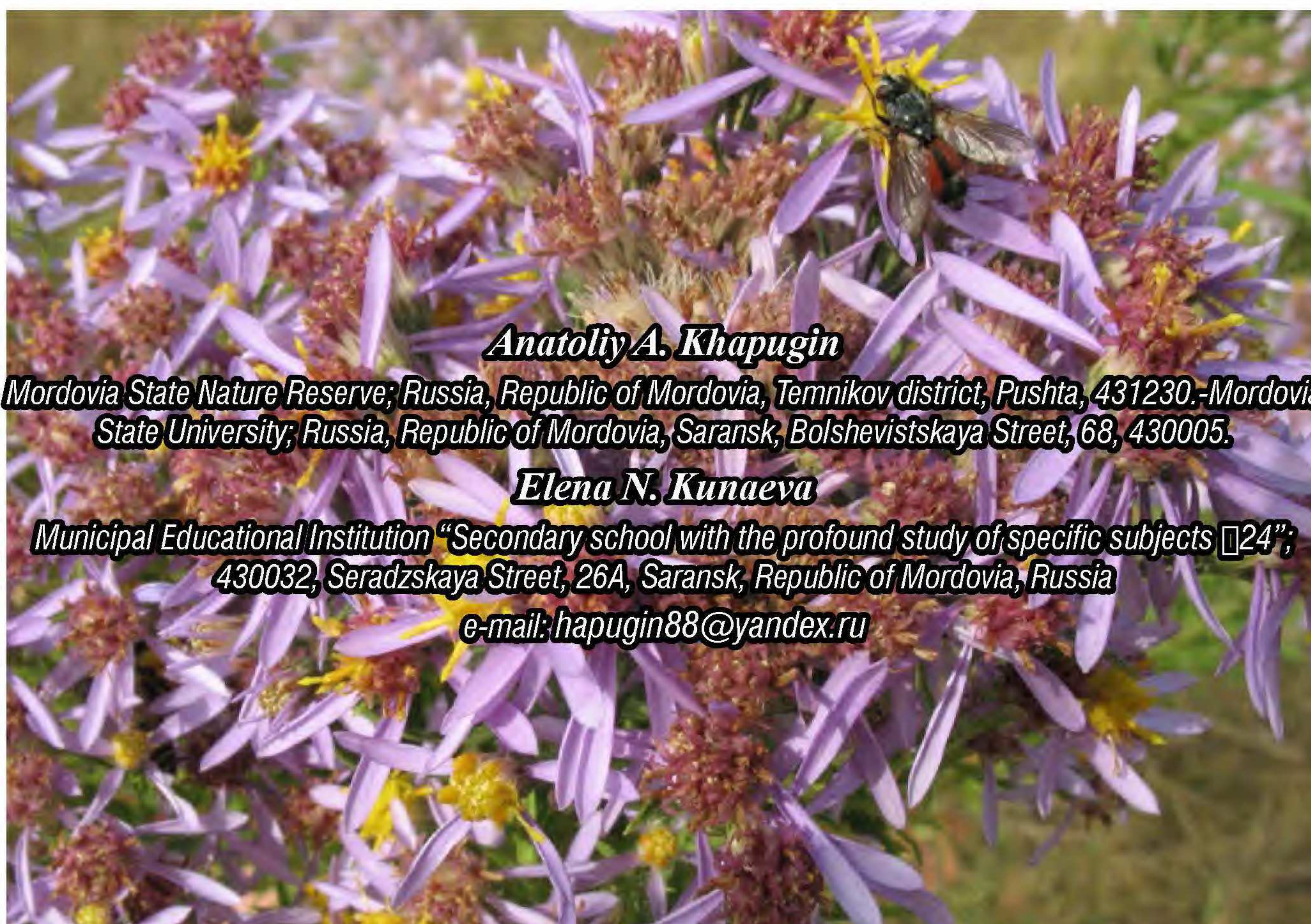


Abundance dynamics of endangered plant species *Galatella rossica* (Asteraceae) in the Republic of Mordovia (Central Russia): Short report

Dinámica de la abundancia de la especie de planta en peligro *Galatella rossica* (Asteraceae) en la República de Mordovia (Rusia Central): Reporte breve



Anatoliy A. Khapugin

Mordovia State Nature Reserve; Russia, Republic of Mordovia, Temnikov district, Pushta, 431230.-Mordovia State University; Russia, Republic of Mordovia, Saransk, Bolshevistskaya Street, 68, 430005.

Elena N. Kunaeva

Municipal Educational Institution "Secondary school with the profound study of specific subjects №24"; 430032, Seradzskaya Street, 26A, Saransk, Republic of Mordovia, Russia
e-mail: hapugin88@yandex.ru



Abstract

The population-based studies of vulnerable plant species provide important data on both their own ecological preferences and environmental conditions of habitats. *Galatella rossica* is endangered plant species included in the *Red Data Book of the Republic of Mordovia* (Central Russia). In the region, it is known from six micropopulations. None of them is located within the regional protected areas network. We have carried out the study of abundance dynamics for two of the known populations: for location 1 –between 2009-2013–, for location 2 –between 2004-2013–. We established that the number of individuals in both studied populations has decreased. It was caused by processes of afforestation and overgrowing in habitats by tall vegetation and shrubs (e.g., *Salix* spp., *Spiraea crenata*). We suggest the resumption of more detail population-based studies in the region.

Keywords: *Galatella rossica*, Asteraceae, abundance dynamics, population-based studies, Republic of Mordovia, *Red Data Book*, afforestation, rare species.

Resumen

Los estudios poblacionales de especies de plantas vulnerables brindan importante información sobre sus preferencias ecológicas y condiciones ambientales de sus hábitats. *Galatella rossica* es una especie de planta en peligro incluida en el *Libro Rojo de la República de Mordovia* (Rusia Central). Se conocen seis micropoblaciones en esta región. Ninguna de ellas se ubica dentro de la red regional de áreas protegidas. Hemos llevado a cabo el estudio de la dinámica de la abundancia en dos de las poblaciones conocidas: en la ubicación 1 –entre 2009 y 2013–, en la ubicación 2 –entre 2004 y 2013–. Determinamos que el número de individuos en ambas poblaciones estudiadas ha disminuido. Esto fue causado por procesos de reforestación y sobrecrecimiento de vegetación alta y arbustos en sus hábitats (p. ej. *Salix* spp., *Spiraea crenata*). Sugerimos la reanudación de estudios de población más detallados en la región.

Palabras clave: *Galatella rossica*, Asteraceae, dinámica de la abundancia, estudios poblacionales, República de Mordovia, libro rojo, reforestación, especie rara.

Introduction

The genus *Galatella* Cass. includes between 30 and 45 species distributed mainly throughout Europe, Russia, Iran, and from India to western China (Ling *et al.*, 1985; Nesom & Robinson, 2007; Tzvelev, 1959). Its main centre of diversity is located within Eastern Europe and Russia. Although main systematic studies of the tribe invariably argued for the independence of the genus *Galatella* with respect to the genus *Aster* (Ling *et al.*, 1985; Nesom, 1994a,b; Nesom & Robinson, 2007; Tzvelev, 1959), this viewpoint remains debatable in regional and national floras of Europe and Asia (Brouillet *et al.*, 2009; Ekim, 2012; Ignatov, 2014; Nesom & Robinson, 2007).

Galatella rossica Novopokr. is one of three *Galatella* species known in the Republic of Mordovia. This is perennial plant 25–150 cm. Numerous stems erect, covered by short hairs. Leaves sessile, linear-lanceolate, glandular-punctate, 8 mm in width and up to 10 cm in length. Anthodes 7–12 mm in length and 8–12 mm in width. Disk flowers are jonquil-yellow, ray flowers – pinkish-purple. Fruits – achenes with albescent pappus (Ignatov, 2014; Merxmüller & Schreider, 1976; Tzvelev, 1994). According to different sources this species is named as *Galatella sedifolia* (L.) Greuter (Greuter, 2003), *G. punctata* (Waldst. et Kit.) Nees (Ignatov, 2014), *Aster sedifolia* L. subsp. *sedifolius* (Merxmüller & Schreider, 1976). We use the name *Galatella rossica* Novopokr.

in consistent with a synopsis flora of the Republic of Mordovia (Silaeva, 2010).

This species is known from most regions of Central Russia, being rare to north. In Mordovia, it was included in regional Red Data Book with category 3 “Rare species” (Resolution, 2015) being known from 6 local populations (Fig. 1). All of them are located in the eastern part of Mordovia, primarily along the Sura river. All *G. rossica* populations are located outside of the established regional Protected Areas Network (Khapugin *et al.*, 2017b). As a result of long-term studies of rare and endangered plants in the Republic of Mordovia, all species from regional Red Data Book were estimated according to IUCN Red List Categories and Criteria (IUCN 2012a,b, 2014). Amongst them, *Galatella rossica* was assessed as an Endangered taxon (Khapugin *et al.*, 2017a).

Long-term monitoring of plant populations often provides significant data about influence main factors on their vitality and status (Čtvrtlíková *et al.*, 2016; Khapugin *et al.*, 2016a; Trowbridge *et al.*, 2016; Webster *et al.*, 2005), especially, it concerns peripheral populations of plant

species (Chau *et al.*, 2013; Khapugin & Chugunov, 2015). Here we report the result of population-based survey of *Galatella rossica* in one of its locations within the Republic of Mordovia (Central Russia).

Material and methods

We investigated two closely located micropopulations on flood meadows in Bolshie Berezniki district of the Republic of Mordovia near the boundary with Ulyanovsk Region (Fig. 1). First of them is a population near lake Belyaevka (location 1: 54.166 N, 46.152 E). Vegetation cover is presented primarily by representatives of families *Fabaceae* and *Poaceae*. The bushes of *Salix* spp. (primarily – *Salix cinerea* L.) and *Acer tataricum* L. are located around this flood meadow. Second micropopulations is located near the former pioneer camp “Zelenaya Polyana” (location 2: 54.177 N, 46.183 E). Here, *Galatella rossica* population is situated at the forest edge. Stand of nearby forest is presented by *Quercus robur* L., *Ulmus glabra* Huds.; shrub layer consists of *Acer tataricum* (striving to reach the first layer), *Populus tremula* L., *Padus avium* Mill., *Frangula alnus* Mill.



Fig. 1. Situation of the Republic of Mordovia in Eastern Europe. Studied *Galatella rossica* populations are designated by circles, other regional populations are marked by squares (Map with modifications from web-site United Nations Geospatial Information Section: <http://www.un.org/Depts/Cartographic/english/htmain.htm>).

During vegetative seasons of 2009-2013, we have carried out estimation of abundance dynamics of *Galatella rossica* individuals in location 1, and during 2004-2013 in location 2. For this purpose, we have counted total number of individuals in each studied location. In order to count the abundance of individuals in each population, each aboveground shoot was considered as one individual.

Results and discussion

As a result of conducted investigations, we found that abundance of *Galatella rossica*

individuals in location 1 has increased from 2009 to 2010 in the first year of study when vegetation cover has been influenced by extremely dry season (Fig. 2). Due to oppression state of main competitors, *Galatella rossica* has increased its own abundance in location 1. However, in next years its abundance has decreased till 147 individuals in 2013 (minimal value over all study period).

This decline of abundance was caused by decrease of grazing and haymaking impacts on this flood meadow. As a consequence,

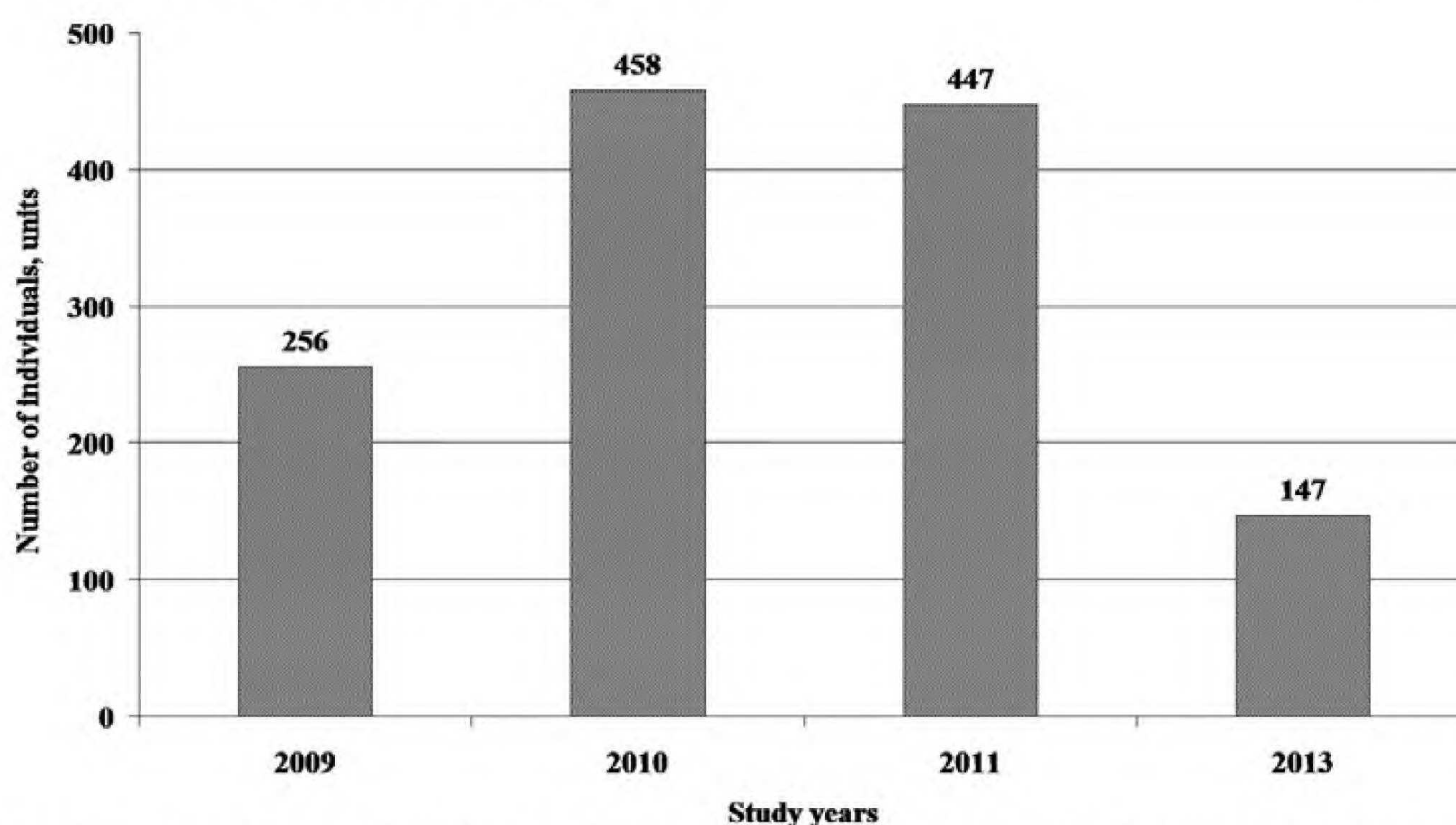


Fig. 2. Abundance dynamics of individuals in *Galatella rossica* population near the lake Belyaevka (location 1) during 2009–2013.

shrub vegetation became to overgrow those areas. As a result *Galatella rossica* could not compete with shrubs and tall herbaceous vegetation; and its population area gradually had declined.

In location 2, in the year 2013 *Galatella rossica* population was presented by the smallest number of individuals over a whole study period (Fig. 3) similarly to situation with location 1. Although this population is much more numerous

in compare with location 1 (the largest number of individuals reached 1424 units in 2008), we have observed that *Galatella rossica* plants located directly near the forest canopy (under shadiness impact) differed by lower vitality. This was reflected in lower height of individuals and anthode's diameter; the flowering stage of these plants has begun earlier in compare with individuals distant of the edge of forest stand. However, these differences were

registered visually; therefore special studies of this phenomenon are needed in future.

Regarding of abundance dynamics in *Galatella rossica* population in location 2, we found that number of individuals varied during the first study years (2004–2006) until the year 2008. In this year we registered sharp increase of the abundance up to

maximal value over the whole study period (Fig. 3). Further we have observed constant decrease in abundance of individuals year by year during the entire subsequent period of our study. In our opinion, there are two interrelated reasons.

At first, the termination of pioneer camp functioning caused the reduction

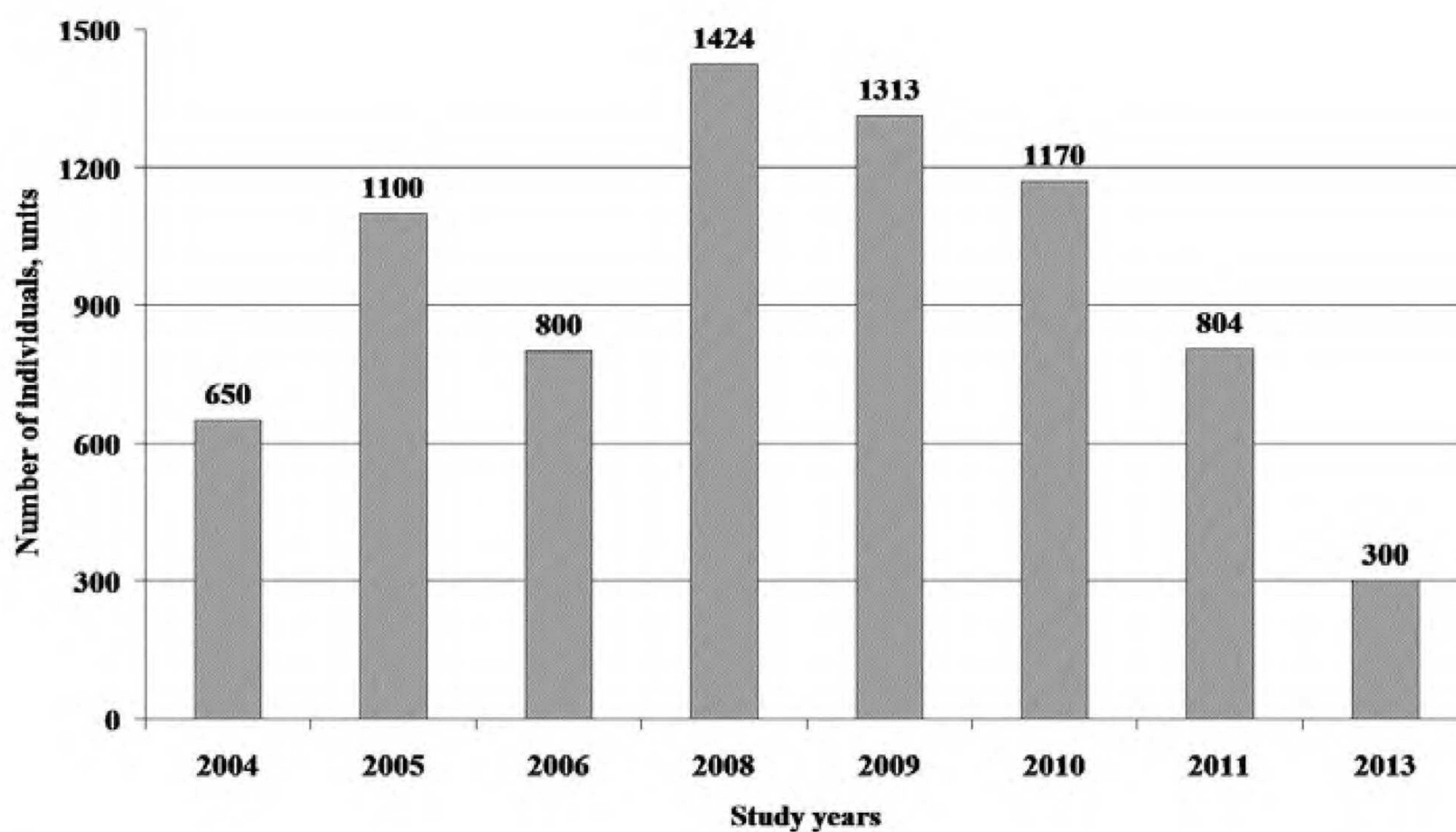


Fig. 3. Abundance dynamics of individuals in *Galatella rossica* population near the former pioneer camp “Zelenaya Polyana” (location 2) during 2004–2013.

of trampling effects at this flood meadow. This in turn led to its overgrowing of tall vegetation that depresses the *Galatella rossica* population. Additionally, large population of *Spiraea crenata* L. is known there. The termination of pioneer camp functioning in 2008 had a positive impact on status of its population. Year by year *Spiraea crenata* population has increasingly expanded on this flood meadow vegetatively and by seeds. Therefore, another one regionally rare species (*Spiraea crenata*) became one more competitor for *Galatella rossica* in location 2.

At second, decrease of anthropogenic impact has resulted in intensification of afforestation processes at forest edge where *Galatella rossica* population is situated. So, active resettlement (seed reproduction) of *Acer tataricum* and *Quercus robur* was observed here. Taking into account that *Acer tataricum* is considered as one of trees forming forest stand here (Khapugin et al., 2016b), we should say that without changes in current situation *Galatella rossica* population in location 2 can disappear due to its displacement by more competitive species.

Conclusion

Taking into account all mentioned above, we can conclude that *Galatella rossica* populations in the Republic of Mordovia suffer of natural succession processes. Main threat for them is complete cessation of grazing in their habitat leading to 1) afforestation of their habitats; 2) overgrowing of habitats by tall vegetation. In our opinion, exactly these factors have caused the decline of studied populations of *Galatella rossica*.

In order to understand what factors influence status of *Galatella rossica* populations in Mordovia, resumption of annual detail population-based studies of this species is necessary. Investigations of age structure of species' populations, long-term abundance dynamics, data on morphometry of different-age individuals, composition of the accompanying flora, seed ecology can provide more complete knowledges on status of this species in Central Russia and to help prepare appropriate recommendations for its conservation in natural habitats.

Acknowledgements

Authors would like to thank the Children's Ecological Organisation "Green World" for the organisation of annual republican camps "Sura" dedicated to the research project "Tree of Land Where I Live".

Literature cited

- Brouillet, L.; T. K. Lowrey; L. Urbatsch; V. Karaman-Castro; G. Sancho; S. Wagstaff & J. C. Semple. 2009. Astereae. In: V. A. Funk, A. Susanna, T. F. Stuessy & R. J. Bayer (eds.). Systematics, Evolution, and Biogeography of Compositae, pp. 589-629. IAPT, Vienna.
- Chau, M. M.; W. R. Reyes & T. A. Ranker. 2013. Ecological factors influencing growth of the endangered Hawaiian fern *Marsilea villosa* and implications for conservation management. American Journal of Botany 100: 1532-1543. DOI: 10.3732/ajb.1200625.
- Čtvrtlíková, M.; J. Hejzlara; J. Vrba; J. Kopáček; J. Nedoma; P. Hekera; A. J. Wade & S. Roy. 2016. Lake water acidification and temperature have a lagged effect on the population dynamics of *Isoëtes echinospora* via offspring recruitment. Ecological Indicators 70: 420-430. DOI: 10.1016/j.ecolind.2016.06.042.
- Ekim, T. 2012. *Galatella* Cass. In: A. Güner, S. Aslan, T. Ekim, M. Vural, M. T. Babaç (eds.). Türkiye Bitkileri Listesi (Damarlı Bitkiler), pp. 161-162. Flora Araştırmaları Derneği ve Nezahat Gökyiğit Botanik Bahçesi: İstanbul, Turkey.
- Greuter, W. 2003. The Euro+Med treatment of Astereae (Compositae) – generic concepts and required new names. Willdenowia 33: 45-47. DOI: 10.3372/wi.33.33103.
- Ignatov, M. S. 2014. *Galatella* Cass. In: Flora of Center of European part of Russia, vol. 11, 357-358. KMK Scientific Press Ltd., Moscow. (In Russian).
- IUCN. 2012a. IUCN Red List Categories and Criteria: Version 3.1, second ed. Gland, UK: Switzerland and Cambridge.
- IUCN. 2012b. Guidelines for Application of IUCN Red List Criteria at Regional and National Levels: Version 4.0. Gland, UK: Switzerland and Cambridge.
- IUCN. 2014. IUCN Standards and Petitions Subcommittee. Guidelines for Using the IUCN Red List Categories and Criteria. Version 11. Prepared by the Standards and Petitions Subcommittee. Available from: <http://www.iucnredlist.org/documents/RedListGuidelines.pdf>. (accessed: 15 February 2017).
- Khapugin, A. A. & G. G. Chugunov. 2015. Two populations of *Lunaria rediviva* L. (Cruciferae Juss.) at the eastern edge of its range. Wulfenia 22: 83-94.
- Khapugin, A. A.; G. G. Chugunov; T. B. Silaeva & E. N. Kunaeva. 2016a. *Neottianthe cucullata* (L.) Schltr. (Orchidaceae Juss.), an endangered orchid in Central Russia. Wulfenia 23: 189-202.
- Khapugin, A. A.; T. B. Silaeva & Yu. N. Utorova. 2016b. Three Maples (*Acer* L., Aceraceae Juss.) in the Republic of Mordovia, Russian Federation. Annales Universitatis Paedagogicae Cracoviensis Studia Naturae 1: 129-143.
- Khapugin, A. A.; G. G. Chugunov; E. V. Vargot & T. B. Silaeva. 2017a. Vascular plants at the protected

areas network of the Republic of Mordovia: present status and prospects. In: S. A. Mukul & A. Z. M. M. Rashid (eds.). Protected Areas: Policies, Management and Future Directions, pp. 203-231. Nova Science Publishers, Inc., USA.

Khapugin, A. A.; T. B. Silaeva; E. V. Vargot; G. G. Chugunov; G. A. Grishutkina; O. G. Grishutkin; E. V. Pismarkina & Ju. S. Orlova. 2017b. Estimation of taxa included in the first volume of the Red Data Book of the Republic of Mordovia (Russia) using the IUCN Red List Categories and Criteria. Nature Conservation Research 2, accepted article. Available from: <http://ncr-journal.bear-land.org/article/48>. (In Russian).

Ling, R.; Y. L. Chen & Z. Shi. 1985. Astereae. In: R. Ling, Y. L. Chen & Z. Shi (eds.). Flora Reipublicae Popularis Sinicae, vol. 74, pp. 70-353. Science Press, Beijing.

Merxmüller, H. & A. Schreider. 1976. *Aster* L. In: T. G. Tutin, V. H. Heywood, N. A. Burges, D. M. Moore, D. H. Valentine, S. M. Walters & D. A. Webb (eds.). Flora Europaea. 4. Plantaginaceae to Compositae (and Rubiaceae), vol. 4, pp. 112-116. Cambridge University Press, Cambridge.

Nesom, G. L. & H. Robinson. 2007. Tribe Astereae Cass. In: J. W. Kadereit & C. Jeffrey (eds.). The families and genera of vascular plants 8. Flowering Plants. Eudicots. Asterales, pp. 316-376. Springer, Berlin. DOI: 10.1007/978-3-540-31051-8_7.

Nesom, G. 1994a. Subtribal classification of the Astereae (Asteraceae). Phytologia 76: 193-274.

Nesom, G. 1994b. Review of the taxonomy of *Aster* sensu lato (Asteraceae: Astereae), emphasizing the New World species. Phytologia 77: 141-297.

Resolution of the Government of the Republic of Mordovia □ 559 from October 1, 2015. 2015. «On Amending Resolution of the Government of the Republic of Mordovia from February 25, 2003 □ 61: “About the Red Data Book of rare and endangered species of plants, fungi and animals of the Republic of Mordovia”». (In Russian).

Silaeva, T. B.; I. V. Kiryukhin; G. G. Chugunov; V. K. Levin; S. R. Mayorov; E. V. Pismarkina; A. M. Ageeva & E. V. Vargot. 2010. Vascular plants of the Republic of Mordovia (synopsis of flora). Publisher of the Mordovia State University, Saransk. (In Russian).

Trowbridge, C. C.; A. Stanley; T. N. Kaye; P. W. Dunwiddie & J. L. Williams. 2016. Long-term effects of prairie restoration on plant community structure

and native population dynamics. Restoration Ecology DOI: 10.1111/rec.12468.

Tzvelev, N. N. 1959. *Galatella* Cass. In: B. K. Schischkin (ed.). Flora of the USSR, vol. 25, pp. 138-172. Publisher of the Academy of Sciences of USSR, Moscow & Leningrad. (In Russian).

Tzvelev, N. N. 1994. *Galatella* Cass. In: N. N. Tzvelev (ed.). Flora of the European part of USSR, vol. 7, pp. 189-194. Nauka, Saint-Petersburg. (In Russian).

Webster, C. R.; M. A. Jenkins & J. H. Rock. 2005. Long-term response of spring flora to chronic herbivory and deer exclusion in Great Smoky Mountains National Park, USA. Biological Conservation 125 (3): 297-307. DOI: 10.1016/j.biocon.2005.03.027

ANEXO



Fig. 1. A-B. *Galatella rossica* (author: Tatyana V. Gorbushina).